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POSITION PAPER

Roles of computing in P^{5}BL: Problem-, project-, product-, process-, and people-based learning

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Abstract

This position paper proposes the P^{5}BL initiative and vision, that is, Problem-, Project-, Product-, Process-, People-Based Learning. A definition is proposed for the P^{5}BL teaching and learning approach. The discussion identifies key pedagogical issues and innovative roles of computing for each of the five critical Ps in a multisite, cross-disciplinary, project-centered, and team-oriented Architecture/Engineering/Construction environment.

Keywords: Teamwork; Project-based Learning; Collaboration

1. INTRODUCTION

Not since the introduction of the chalkboard in the 19th century has the curriculum and classroom been so challenged in regard to its basic design configuration and pedagogical setting. It is the synergy of powerful computers, good software, and the Internet that today provides the first real challenge to the traditional classroom and learning setting. They challenge the philosophy of how one teaches, of the relationship between teacher and student, of the active role of academia and industry in the learning environment, of the way in which a classroom is structured, and the nature of curriculum.

Problem-, Project-, Product-, Process-, and People-Based Learning (P^{5}BL) is about teaching and learning teamwork in the information age. P^{5}BL is a methodology of teaching and learning that focuses on *problem*-based, *project*-organized activities that produce a *product* for a client. P^{5}BL is based on reengineered *processes* that bring *people* from multiple disciplines together. The specific P^{5}BL initiative and vision described in this paper comes in response to the need perceived by the Architecture/Engineering/Construction (A/E/C) industry to improve and broaden the competence of engineering students to:

- exercise the acquired theoretical knowledge and understand the role of the discipline-specific knowledge in a multidisciplinary, collaborative, practical project-centered environment;
- recognize the relationship of the engineering enterprise to the social/economic/political context of engineering practice and the key role of this context in engineering decisions; and
- learn how to participate in and lead multidisciplinary teams and take advantage of computational prototyping facilities and emerging information technologies for collaborative work to design and build environmentally conscious and high-quality facilities faster and more economically.

P^{5}BL represents an innovative teaching and learning approach that is aimed to address the Accreditation Board for Engineering and Technology's requirement for multidisciplinary team experiences.

2. PROBLEM-BASED LEARNING

Students should experience design and engineering as a social, teamwork activity. Engineers are problem solvers. To solve a problem the engineer has to determine an objective, constraints that affect the problem, marshal their resources, inventory the tools, and develop solutions. To define the objectives of the problem in the building industry, one has to

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communicate. The engineer does not decide what has to be built. The owner and architect decide what has to be built. Many of the constraints of what has to be built arise from the construction domain. To find out what the constraints are, the engineer has to listen to the contractor. It is important that the engineer listens to the owner, architect, and contractor to define the problem, and come up with solutions, more than one. And then iterate again and again to determine which of the solutions is the best solution.

Computing can and will support this learning experience by providing students with tools to determine, express, visualize, manipulate, and communicate the objectives, constraints, problems, and solutions among owner and team members.

3. PROJECT-BASED LEARNING

There is a major disjunction between the work of a student and the work of any A/E/C practitioner. P[5]BL approach proposes to use real-world projects to bridge the discipline theory, design theory, and practice in several ways:

- *Role modeling in cyberspace* will enable students to:
  - bring real-world projects into the classroom and attend in real time, as silent participants, project meetings that take place in any design-build or consulting firm, or watch the specific designer's activities as a remote apprentice. Computing can support this role modeling activity via videoconferencing and desktop sharing tools, or in the near future through cameras operated via World Wide Web.
  - access project case studies in World Wide Web public domains.
  - bring practitioners who are geographically distributed to the classroom to discuss past project via videoconferencing and desktop sharing.
- *Real-world projects* that engage a multidisciplinary team. The project will impact:
  - the rhythm of work, which will be closer to the accelerated work pace of an A/E/C project team. Time deadlines will force the students to balance the need to understand with the need to act.
  - the peer-to-peer learning and relationships. Teamwork is a process of reaching a shared understanding of the design and construction domains, the requirements, the building to be built, the design process itself and the commitments it entails. The understanding emerges over time as each team member develops an understanding of his/her own part of the project and provides information that allows others to progress. The process involves communication, negotiation, and team learning.

To support the time constraints and teamwork activities, students will use Internet-mediated computer environments and mobile computing that will improve cross-discipline communication, collaboration, and coordination over time; that is, synchronous and asynchronous, and space; that is, collocated and geographically distributed settings.

4. PRODUCT-BASED LEARNING

Students learn best when engrossed in the topic, motivated to seek out new knowledge and skills because they need them to produce a product within the given time frame of a project. To support the teamwork process of reaching a shared understanding of the evolving product, students will use a suite of virtual reality, Internet-mediated and Web-mediated collaboration technologies to: explore 3D shared product models, capture the multidisciplinary design intents and perspectives, perform concurrent multicriteria performance-based evaluations, simulate and visualize the construction site over time, walk through and manipulate the virtual build environment, and use shared cyberworkspaces to archive and retrieve their product models and documents.

5. PROCESS-BASED LEARNING

There is a major transition that students have to go through as they adapt to and adopt new computer technologies. As students are engaged in P[5]BL they should actively reflect upon the change in the tasks, interactions, and overall process as a consequence of using specific information technologies. They have to identify new communication protocols and team organization structures necessary to take full advantage of the information technologies that support teamwork.

In addition, computer tools will help students understand how organization structures, project tasks, and collaboration technologies can be modeled and simulated to analyze and predict the impact of communication technologies on organization behavior and performance. This learning experience will help the students develop means to assess future information technologies and understand which technology to adopt for specific projects, teams, and organization structures.

6. PEOPLE-BASED LEARNING

P[5]BL is aimed to create a new culture that brings together faculty, practitioners, and students from different disciplines, who will be geographically distributed. One of the innovative features of P[5]BL is represented by the role each of the participants will play, that is:

- undergraduate and graduate students will play the roles of apprentice and journeyman, respectively. They experience team dynamics as members of a multidisciplinary teams.

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- faculty members will play the role of "master builders." Their role is changing from the traditional teacher who delivers the course material in class to the *coach*.
- industry representatives play the role of mentors and sponsors. They become active participants in the teaching process and education of the next generation of practitioners.

Computer tools will play a key role in bridging all the participants of P[5]BL together through shared workspaces on the World Wide Web, integrated tools that enable information sharing and exchange, and videoconferencing that can be used for face-to-face team meetings, distant learning lectures, office hours in cyberspace, and project presentations.

Finally, to support P[5]BL, the classroom setting will change to provide a flexible learning space that can be reconfigured by faculty and students on an as-needed basis to support the different learning and teaching activities described above.

The P[5]BL vision has been exercised for the past couple of years in the innovative A/E/C course offered at Stanford's Civil Engineering Department in collaboration with UC Berkeley (Fruchter, 1996).

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